Mathematics

Math-4m

Prep 1

First Term

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Prepared by

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Ready to Lesson 1

RATIO

Real Life Connection

Ratios help us compare quantities in daily life.
For example, a recipe may need 2 cups of flour for 3 cups of sugar.
This means the ratio of flour to sugar is 2 : 3.

Let's Learn

By the end of this lesson, I will be able to:

- Understand the meaning of ratio.
- Write ratios in different forms.
- Find equivalent ratios.
- Write ratios in simplest form.
- Understand and write unit rates.
- Solve problems using ratios in real life.

Key Concept

A **ratio** compares two quantities of the same kind.
It shows the relationship between a part and a part, a part and a whole, or a whole and a part.

Ratio of a to b can be written in three forms:

a to b | a : b | $\frac{a}{b}$ (a over b)

Where a and b are the two terms of the ratio.

Symbols Explanation

a , b	→ numbers or quantities
a : b	→ read as "a is to b"
a/b	→ a divided by b (a over b)
:	→ ratio symbol (is to)
/	→ fraction bar (divided by)

Types of Ratios

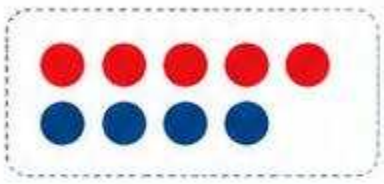
Part to Part
Compare one part to another part.
Example: boys to girls = 7 : 8

Part to Whole
Compare one part to the whole.
Example: boys to total = 7 : 15

Whole to Part
Compare the whole to one part.
Example: total to boys = 15 : 7

Examples

1. A box contains 6 red balls and 4 blue balls.
   a) Write the ratio of red to blue.
   b) Write the ratio of blue to red.
   c) Write the ratio of red to total.

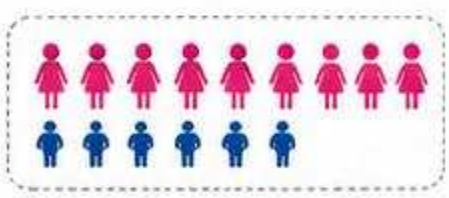


Solution:
a) 6 : 4 b) 4 : 6 c) 6 : 10

2. A recipe needs 2 cups of flour and 3 cups of sugar.
   a) Write the ratio of flour to sugar.
   b) Write the ratio of sugar to flour.
   c) Write the ratio of total cups to sugar.

Solution:
a) 2 : 3 b) 3 : 2 c) 5 : 3

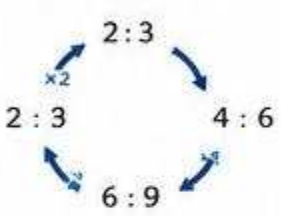
3. In a class of 18 students, 10 are girls.
   a) Write the ratio of girls to boys.
   b) Write the ratio of boys to total.
   c) Write the ratio of total to girls.



Solution:
a) 10 : 8 b) 8 : 18 c) 18 : 10

Equivalent Ratios

Equivalent ratios are different ratios that have the same value.



Example
Find two ratios equivalent to 2 : 3

Solution:
Multiply both terms by 2 → 4 : 6
Multiply both terms by 3 → 6 : 9
So, 4 : 6 and 6 : 9 are equivalent to 2 : 3.

Ratio in Simplest Form

We divide both terms by their GCF until no common factor (except 1).

Example
Write 24 : 36 in simplest form.

Solution:
GCF of 24 and 36 = 12
24 ÷ 12 : 36 ÷ 12 = 2 : 3

	24	36
2	24	36
2	12	18
3	6	9
2	2	3
	1	1

Unit Rate

A unit rate compares a quantity to one unit of another quantity.

Example: 120 km in 3 hours → 120 km to 3 hours = $\frac{120}{3}$ = 40 km per 1 hour.

Teacher:

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Equivalent Ratios

Equivalent ratios are ratios that are equal in value even though the numbers are different.
You can get equivalent ratios by:

- Multiplying both terms of the ratio by the same number (except 0).
- Dividing both terms of the ratio by the same number (common factor).

Examples

1. Multiply both terms by the number.

2 : 3 → (× 2) 4 : 6 → (× 3) 6 : 9 → (× 4) 8 : 12 (also × 4 from 4 : 6)

2. Divide both terms by the same number.

20 : 30 → (÷ 2) 10 : 15 → (÷ 5) 4 : 6 → (÷ 2) 2 : 3 (also ÷ 10 from 10 : 15)

Note

Zero has no value in a ratio. Division by zero is not allowed.

Finding a Missing Term in a Ratio

If $a : b = c : d$, then $\frac{a}{b} = \frac{c}{d}$. You can use cross multiplication to find the missing term.

Example

If 3 : 5 = x : 15, find x.

Solution:

$\frac{3}{5} = \frac{x}{15} \rightarrow 3 \times 15 = 5 \times x$

$45 = 5x \rightarrow x = 9$

Equivalent ratios are like equal balances.

Ratio in Simplest Term

A ratio is in simplest form when the two terms have no common factor except 1 (the GCF is 1).

Example

Write the simplest form of 18 : 24

Solution:

GCF of 18 and 24 is 6.

18 ÷ 6 : 24 ÷ 6 = 3 : 4

18		24
2 | 18	2 |	24
3 | 9	2 |	12
3 | 3	3 |	6
1		2
		1

Common factors removed → 3 : 4

Writing a Ratio in Different Forms

Situation	Ratio in Words	Part to Part	Part to Whole	Whole to Part
There are 4 red balls and 6 blue balls. ●●●● ●●●●●●	The ratio of red to blue is 4 to 6.	4 : 6	4 : 10 (red to total)	10 : 4 (total to red)
There are 4 red balls and 6 blue balls.	The ratio of blue to red is 6 to 4.	6 : 4	6 : 10 (blue to total)	10 : 6 (total to blue)
There are 4 red balls and 6 blue balls (total = 10).	The ratio of total to red is 10 to 4.	—	—	10 : 4 (total to red)

Try It Yourself

A Write each ratio in simplest form.

1 12 : 18 = _____ 2 15 : 25 = _____

3 30 : 45 = _____ 4 14 : 21 = _____

B Write two ratios equivalent to each of the following.

1 2 : 5 → _____ , _____

2 3 : 4 → _____ , _____

3 5 : 8 → _____ , _____

C Complete the following.

1 4 : 7 = _____ : 14 2 2 : 9 = 6 : _____

3 3 : 5 = 9 : _____ 4 5 : 12 = _____ : 36

D Find the value of x.

1 3 : 7 = x : 21 2 x : 6 = 4 : 9

3 5 : x = 15 : 24 4 2 : 3 = 10 : x

Real Life Application

1. A class has 12 boys and 16 girls.
Write the ratio of:
a) boys to girls. _____
b) girls to boys. _____
c) boys to the total number of students. _____
d) girls to the total number of students. _____

2. A recipe uses 3 cups of rice and 5 cups of water.
If you want to keep the same ratio, how many cups of water should you use with 6 cups of rice? _____

3. Ahmed reads 90 pages in 6 days.
At the same rate, how many pages will he read in 10 days?
_____

4. In a sports team, the ratio of players to coaches is 15 : 2.
If the team has 3 coaches, how many players are there?
_____

Remember

Equivalent ratios are different ratios with the same value.

Multiply or divide both terms by the same number. → Simplify to the lowest terms. → Use ratios in everyday life to solve problems.

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Unit Rate (Continued)

A unit rate is a rate whose denominator is 1.

Examples

1. 90 kilometers in 3 hours.

$$\text{Unit rate} = \frac{90}{3} \text{ kilometers in 1 hour}$$
$$= 30 \text{ kilometers per 1 hour}$$
$$= 30 \text{ km per hour}$$

2. 150 pages in 5 days.

$$\text{Unit rate} = \frac{150}{5} \text{ pages in 1 day}$$
$$= 30 \text{ pages per day}$$

Converting a Rate to a Unit Rate

To convert a rate to a unit rate, divide both terms by the denominator (second number).

Example

180 kilometers in 3 hours

$$\frac{180 \text{ kilometers}}{3 \text{ hours}} = \frac{180 \div 3 \text{ kilometers}}{3 \div 3 \text{ hours}} = \frac{60 \text{ kilometers}}{1 \text{ hour}}$$
$$= 60 \text{ kilometers per hour}$$

Converting a Unit Rate to Another Unit Rate

To convert a unit rate to another unit rate, multiply both terms by the same number.

Example

60 kilometers per hour

To find kilometers per 2 hours:

$$60 \text{ km per hour} = \frac{60}{1} \times 2 \xrightarrow{\times 2} = \frac{60 \times 2}{1 \times 2} = \frac{120}{2}$$
$$= 120 \text{ kilometers in 2 hours}$$

Try It Yourself

A Convert each rate to a unit rate.

1. 240 km in 6 hours = _____ per 1 hour
2. 75 pages in 5 days = _____ per 1 day
3. 120 liters in 4 hours = _____ per 1 hour
4. 360 meters in 9 seconds = _____ per 1 second

B Convert each unit rate to the given rate.

1. 40 km per hour → for 3 hours = _____
2. 25 pages per day → for 4 days = _____
3. 15 liters per minute → for 7 minutes = _____

C Write each rate as a unit rate.

1. 48 students in 6 classes = _____
2. 96 apples in 8 baskets = _____

D Write each unit rate as another unit rate.

1. 20 km per hour → per 2 hours = _____
2. 18 pages per day → per 3 days = _____

Problem Solving

1. A car travels 300 kilometers in 5 hours.
   a) Find the unit rate (km per hour).
   _____
   b) How many kilometers will it travel in 7 hours at the same rate?
   _____

2. A factory produces 480 bottles in 6 hours.
   a) What is the unit rate (bottles per hour)?
   _____
   b) How many bottles will it produce in 9 hours at the same rate?
   _____

3. A printer prints 540 pages in 3 hours.
   a) What is the unit rate (pages per hour)?
   _____
   b) How many pages will it print in 5 hours at the same rate?
   _____

Compare and Choose

Choose the correct answer.

1. The ratio $\frac{3}{5}$ is equivalent to:
   (a) $\frac{6}{10}$ (b) $\frac{9}{14}$ (c) $\frac{12}{20}$ (d) $\frac{4}{7}$
2. The simplest form of the ratio 36 : 48 is:
   (a) 2 : 3 (b) 3 : 4 (c) 3 : 6 (d) 4 : 6
3. Which of the following is a unit rate?
   (a) 90 km in 3 hours (b) 45 pages in 5 days
   (c) 30 km per hour (d) 60 liters in 2 hours
4. If the ratio of boys to girls is 2 : 3 and there are 10 boys, how many girls are there?
   (a) 10 (b) 12 (c) 15 (d) 18

Think and Challenge

1. If $a : b = 3 : 5$ and $b : c = 5 : 7$, find the ratio $a : b : c$ in simplest form.
   _____
2. A recipe uses flour and sugar in the ratio 4 : 3.
   If we use 1.2 kg of flour, how much sugar should we use?
   _____

3. A boat travels 96 km downstream in 4 hours.
   The same boat travels 64 km upstream in 4 hours.
   Find the unit rate in each case and compare.
   _____

Quick Review

1. The ratio of 8 to 12 in simplest form is _____ .
2. Two equivalent ratios to 5 : 6 are _____ and _____ .
3. $\frac{9}{15}$ in simplest form is _____ .
4. If $a : b = 4 : 7$ and $a = 20$, then b = _____ .
5. 210 km in 3 hours = _____ km per hour.
6. 16 pages in 2 days = _____ pages per day.

Teacher: _____

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Unit 1

Numbers and Operations on Them

Lesson 1

Proportion

Learning Outcomes

- Define a proportion.
- Write a proportional relationship.
- Identify proportional and non-proportional relationships.
- Solve proportions using cross multiplication.
- Apply proportion to solve real-life problems.
- Represent proportional relationships graphically.

Vocabulary

- Ratio
- Proportion
- Means
- Extremes
- Cross Multiplication

Lesson Map

1. Concept of Proportion
2. Writing Proportion
3. Property of Cross Multiplication
4. Solving Proportion
5. Life Applications
6. Graphical Representation

1 Concept of Proportion

A proportion is an equality between two ratios.

Example : $\frac{2}{3} = \frac{4}{6}$ (Equality of two ratios)

Means and Extremes

In a proportion $\frac{a}{b} = \frac{c}{d}$:

- The middle terms (b and c) are called the Means.
- The first and last terms (a and d) are called the Extremes.

2 Writing a Proportion

If a, b, c and d are proportional quantities, then $\frac{a}{b} = \frac{c}{d}$

Example : 2, 3, 4 and 6 are proportional quantities.

$$\frac{2}{3} = \frac{4}{6}$$

Remember

- If $\frac{a}{b} = \frac{c}{d}$ then a : b = c : d
- Proportional quantities change in the same ratio.

3 Property of Cross Multiplication

In any proportion, the product of the extremes equals the product of the means.

In other words : Extreme × Extreme = Mean × Mean

Example : If $\frac{3}{5} = \frac{6}{10}$ → then $3 \times 10 = 5 \times 6$

$30 = 30$ ✓ True

Important

If $\frac{a}{b} = \frac{c}{d}$

then $a \times d = b \times c$

Note

Use cross multiplication when solving proportions.

Worked Examples

1 Determine whether the following pair of ratios is a proportion.

$\frac{2}{3}$, $\frac{4}{6}$

Solution :

Cross multiply : $2 \times 6 = 3 \times 4$

$12 = 12$

Since the products are equal, the ratios represent a proportion.

2 Determine whether the following pair of ratios is a proportion.

$\frac{3}{4}$, $\frac{4}{7}$

Solution :

Cross multiply : $3 \times 7 = 4 \times 4$

$21 \neq 16$

Since the products are **not** equal, the ratios do **not** represent a proportion.

3 Determine the missing number (x) so that $\frac{5}{x} = \frac{10}{24}$

Solution :

Cross multiply : $5 \times 24 = 10 \times x$

$120 = 10x$

$x = \frac{120}{10} = 12$

Practice Set 1

A Determine whether each of the following pairs of ratios represents a proportion.

1. $\frac{1}{2}$, $\frac{3}{6}$
2. $\frac{4}{5}$, $\frac{8}{10}$
3. $\frac{7}{9}$, $\frac{14}{18}$
4. $\frac{2}{5}$, $\frac{3}{7}$

B Find the missing number in each proportion.

1. $\frac{x}{4} = \frac{3}{8}$
2. $\frac{5}{x} = \frac{15}{20}$
3. $\frac{7}{11} = \frac{x}{55}$
4. $\frac{9}{x} = \frac{27}{36}$

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Lesson 1

Proportion

4 Solving Proportion

Solving a proportion means finding the unknown value in it.

Example 1 Solve : $\frac{3}{7} = \frac{x}{14}$

Solution :

1. Cross multiply : $3 \times 14 = 7 \times x$
2. Simplify : $42 = 7x$
3. Divide by 7 : $x = \frac{42}{7} = \boxed{6}$

Example 2 Solve : $\frac{5}{8} = \frac{15}{x}$

Solution :

1. Cross multiply : $5 \times x = 8 \times 15$
2. Simplify : $5x = 120$
3. Divide by 5 : $x = \frac{120}{5} = \boxed{24}$

Shortcut Box

Use cross multiplication to solve quickly.

If $\frac{a}{b} = \frac{c}{d}$

then $a \times d = b \times c$

Keep the order of the terms when writing a proportion.

5 Solving for an Unknown in More Forms

Example 3 Solve : $\frac{x}{9} = \frac{6}{27}$

Solution :

1. Cross multiply : $x \times 27 = 9 \times 6$
2. Simplify : $27x = 54$
3. Divide by 27 : $x = \frac{54}{27} = \boxed{2}$

Example 4 Solve : $\frac{2}{x} = \frac{5}{15}$

Solution :

1. Cross multiply : $2 \times 15 = 5 \times x$
2. Simplify : $30 = 5x$
3. Divide by 5 : $x = \frac{30}{5} = \boxed{6}$

Example 5 Solve : $\frac{x-2}{5} = \frac{12}{20}$

Solution :

1. Simplify the right ratio : $\frac{12}{20} = \frac{3}{5}$
2. So, $\frac{x-2}{5} = \frac{3}{5}$
3. Cross multiply : $5(x-2) = 5 \times 3$
4. Simplify : $5x - 10 = 15$
5. Add 10 : $5x = 25$
6. Divide by 5 : $x = \frac{25}{5} = \boxed{5}$

Common Mistakes

- Forgeting to cross multiply.
- Reversing the order of terms.
- Dividing by the wrong number.
- Not simplifying before dividing.

Think Higher

If $\frac{a}{b} = \frac{c}{d}$ and $b + d = 15$, $b = 3d$ where a, b, c and d are natural numbers. Find the values of a, b, c and d.

Note

A proportion has infinitely many equivalent forms. For example :

$\frac{2}{3} = \frac{4}{6} = \frac{6}{9} = \frac{8}{12} = \ldots$

Practice Set 2

A Solve for the unknown in each proportion.

1. $\frac{4}{9} = \frac{x}{27}$
2. $\frac{x}{5} = \frac{8}{15}$
3. $\frac{3}{x} = \frac{9}{18}$
4. $\frac{x}{12} = \frac{7}{18}$
5. $\frac{2}{x} = \frac{10}{25}$
6. $\frac{5}{14} = \frac{x}{42}$
7. $\frac{x-1}{4} = \frac{3}{8}$
8. $\frac{2x+1}{5} = \frac{9}{20}$

B If the given ratios are in proportion, find x.

1. If $\frac{2}{3} = \frac{4}{x}$
2. If $\frac{x}{7} = \frac{15}{21}$
3. If $\frac{6}{x} = \frac{18}{24}$
4. If $\frac{x}{9} = \frac{16}{36}$

C Solve for the unknown in each proportion.

1. A recipe uses 2 cups of sugar for 5 cups of flour. How many cups of sugar are needed for 15 cups of flour?
2. A map scale is 3 cm represents 9 km. What is the actual distance if the map distance is 7 cm?
3. 4 workers can finish a job in 6 days. How many days will 3 workers take to finish the same job at the same rate?

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6 Life Applications on Proportion

Many real-life situations can be solved using proportion.

Example 6

A recipe needs 2 cups of rice to serve 5 people.
How many cups of rice are needed to serve 15 people?

Solution :

Let x be the number of cups of rice for 15 people.

$$\frac{2}{5} = \frac{x}{15}$$

Cross multiply : $2 \times 15 = 5 \times x$

$$30 = 5x$$

$$x = \frac{30}{5} = \boxed{6}$$

So, 6 cups of rice are needed to serve 15 people.

Example 7

A car travels 240 km using 20 liters of fuel.
How many liters will it use to travel 360 km at the same rate?

Solution :

Let x be the liters of fuel needed for 360 km.

$$\frac{20}{240} = \frac{x}{360}$$

Cross multiply : $20 \times 360 = 240 \times x$

$$7200 = 240x$$

$$x = \frac{7200}{240} = \boxed{30}$$

So, 30 liters of fuel are needed.

Example 8 Fill in the missing values in each table. Then, write the proportion.

1

Number of pens	2	4	6	8	10
Price (LE)	6	12	18		30

Since the relationship is proportional :

The constant of proportion $= \frac{6}{2} = 3$

So, Price $= 3 \times$ (Number of pens)

Thus, Price for 8 pens $= 3 \times 8 = \boxed{24}$

Proportion : $\frac{\text{Number of pens}}{\text{Price}} = \frac{2}{6} = \frac{4}{12} = \frac{6}{18} = \frac{8}{24} = \frac{10}{30}$

2

Time (hours)	1	2	3	4	5
Distance (km)	60		180	240	300

Constant of proportion $= \frac{60}{1} = 60$

Distance $= 60 \times$ (Time)

Thus, Distance for 2 hours $= 60 \times 2 = \boxed{120}$

Proportion : $\frac{\text{Time}}{\text{Distance}} = \frac{1}{60} = \frac{2}{120} = \frac{3}{180} = \frac{4}{240} = \frac{5}{300}$

7 Graphical Representation of Proportion

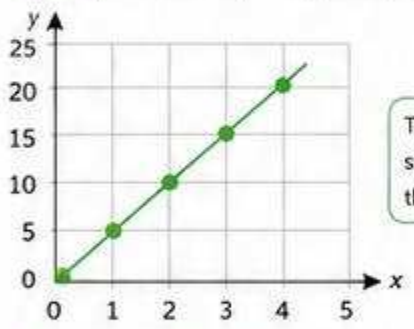
Key Idea

- If points on a graph lie on a straight line passing through the origin (0, 0), then the relationship represents a proportion.
- If points do not lie on such a line, the relationship does not represent a proportion.

Example 9

The table shows a proportional relationship.

x	0	1	2	3	4
y	0	5	10	15	20



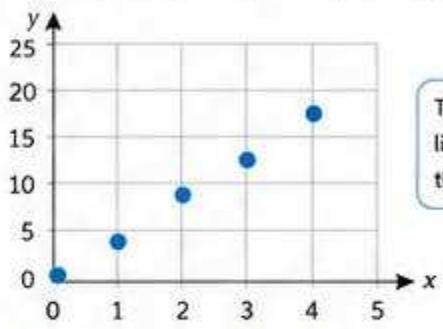
The points lie on a straight line passing through the origin.

So, y is **proportional** to x.

Example 10

The table does not represent a proportion.

x	0	1	2	3	4
y	0	4	9	13	18



The points do not lie on a straight line through the origin.

So, y is **not proportional** to x.

Practice Set 3

A Solve each problem using proportion.

1 25 workers can build a wall in 12 days. How many workers are needed to build the same wall in 8 days?

2 A faucet fills a tank in 6 hours. How long will it take to fill the same tank if the water flow is 2 times faster?

B Complete the tables.

1

x	1	2	3	4
y	3	6		15

2

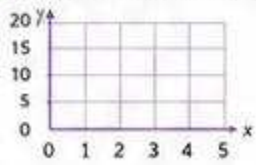
Time (h)	1	2	3	4	5
Distance (km)	50		150	200	

3

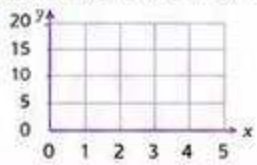
Number of books	2	4	6	8	10
Price (LE)	40		120		200

C Graph each set of values on the grid and state whether it represents a proportion.

1 (0, 0), (1, 3), (2, 6), (3, 9), (4, 12)



2 (0, 0), (1, 2), (2, 5), (3, 7), (4, 10)



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8 Comprehensive Review

A Choose the correct answer.

1 Which of the following represents a proportion?

a) $\frac{2}{3} = \frac{4}{5}$ b) $\frac{3}{4} = \frac{6}{8}$

c) $\frac{2}{5} = \frac{4}{9}$ d) $\frac{5}{7} = \frac{10}{21}$

2 If $a : b = 2 : 3$ and $b : c = 3 : 4$, then $a : c$ = ?

a) 2 : 4 b) 4 : 9

c) 6 : 12 d) 2 : 9

3 If $\frac{3}{x} = \frac{9}{15}$, then x = ?

a) 3 b) 5

c) 6 d) 15

4 The constant of proportion in the table y is proportional to x.

x	2	3	4	5
y	6	9	12	15

a) 2 b) 3

c) 4 d) 5

B Complete the following.

1 If $\frac{2}{3} = \frac{6}{x}$, then x = _____

2 $\frac{a}{b} = \frac{c}{d}$ means $a \times d$ = _____

3 In $\frac{5}{7} = \frac{10}{14}$, the means are _____ and the extremes are _____.

4 If 4 liters of paint cover 30 m², then 1 liter covers _____ m².

5 $\frac{3}{5} = \frac{\square}{20}$

C Put (✓) or (✗).

1 In any proportion, the sum of the extremes equals the sum of the means. ☐

2 $\frac{4}{6} = \frac{8}{12}$ is a proportion. ☐

3 $\frac{2}{3} = \frac{4}{5}$ ☐

4 If $a : b = c : d$ then $\frac{a}{c} = \frac{b}{d}$. ☐

D Solve the following.

1 $\frac{7}{9} = \frac{x}{18}$ x = ☐

2 $\frac{x-4}{6} = \frac{3}{2}$ x = ☐

3 $\frac{5}{x} = \frac{15}{24}$ x = ☐

4 $\frac{2}{3} = \frac{6}{x}$ x = ☐

5 $\frac{3x-1}{5} = \frac{5}{2}$ x = ☐

E Challenge Question

If a, b, c and d are proportional quantities such that $\frac{a}{2} = \frac{b}{3} = \frac{c}{4} = \frac{d}{5}$ and $b = 18$, find the values of a, c and d.

a = ☐ c = ☐ d = ☐

Homework

A Solve for the unknown in each proportion.

1 $\frac{2}{5} = \frac{x}{20}$ ☐

2 $\frac{x}{9} = \frac{4}{3}$ ☐

3 $\frac{7}{x} = \frac{21}{18}$ ☐

4 $\frac{3}{4} = \frac{15}{x}$ ☐

5 $\frac{x+3}{7} = \frac{2}{5}$ ☐

6 $\frac{2x-1}{3} = \frac{5}{6}$ ☐

B If the ratios are in proportion, find x.

1 If $\frac{2}{3} = \frac{x}{12}$ ☐

2 If $\frac{3}{5} = \frac{18}{x}$ ☐

3 If $\frac{x}{14} = \frac{6}{7}$ ☐

4 If $\frac{8}{x} = \frac{16}{24}$ ☐

5 If $\frac{x-2}{5} = \frac{3}{10}$ ☐

6 If $\frac{4}{x+1} = \frac{2}{7}$ ☐

C Solve the following problems.

1 A machine produces 120 parts in 6 hours. How many parts will it produce in 9 hours at the same rate?

Answer: _____

2 5 workers can paint a wall in 8 days. How many workers are needed to paint the same wall in 5 days?

Answer: _____

3 A car consumes 7 liters of fuel to travel 84 km. How many liters will it consume to travel 180 km?

Answer: _____

4 A recipe uses 3 cups of milk to make 12 cupcakes. How many cups are needed to make 20 cupcakes?

Answer: _____

D Complete the tables and state whether the relationship is proportional.

1

x	1	2	3	4	5
y	2	4	☐	8	☐

Is it proportional? _____

2

Time (h)	1	2	3	4
Distance (km)	60	☐	180	240

Is it proportional? _____

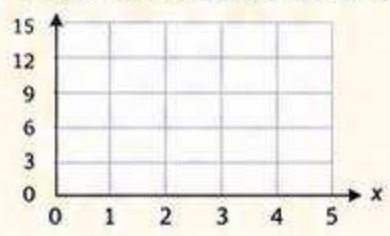
3

Number of workers	2	4	6	8
Days	24	☐	8	☐

Is it proportional? _____

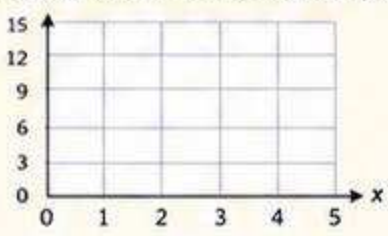
E Graph each set of values on the grid. Then decide whether it represents a proportion.

1 (0, 0), (1, 3), (2, 6), (3, 9), (4, 12)



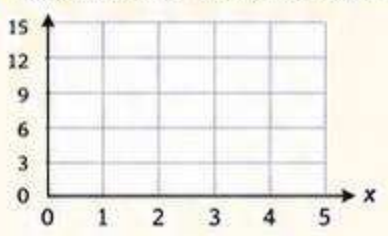
Proportion? _____

2 (0, 0), (1, 2), (2, 5), (3, 7), (4, 10)



Proportion? _____

3 (0, 0), (1, 4), (2, 8), (3, 12), (4, 16)



Proportion? _____

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Homework

Practice makes perfect! Do your best.

A Solve for the unknown in each proportion.

1. $\frac{2}{5} = \frac{x}{25}$ _____
2. $\frac{x}{6} = \frac{9}{18}$ _____
3. $\frac{4}{x} = \frac{12}{15}$ _____
4. $\frac{x}{15} = \frac{2}{3}$ _____
5. $\frac{7}{3} = \frac{x}{21}$ _____
6. $\frac{5x}{12} = \frac{15}{36}$ _____
7. $\frac{x-2}{5} = \frac{6}{15}$ _____
8. $\frac{3}{x+1} = \frac{1}{4}$ _____

B If the ratios are in proportion, find x.

1. If $\frac{2}{3} = \frac{4}{x}$ _____
2. If $\frac{3}{5} = \frac{x}{25}$ _____
3. If $\frac{x}{8} = \frac{15}{24}$ _____
4. If $\frac{5}{x} = \frac{10}{18}$ _____
5. If $\frac{x+2}{6} = \frac{5}{9}$ _____
6. If $\frac{2x-1}{7} = \frac{3}{14}$ _____

C Write a proportion for each situation.

1. The ratio of boys to girls in a class is 3 : 4.
   If there are 18 boys, how many girls are there?
   Proportion : _____
2. A room is 5 m long and 3 m wide.
   If a model of the room is 10 cm long,
   what is its width in cm?
   Proportion : _____
3. A map scale is 1 cm : 8 km.
   If the distance on the map is 4.5 cm,
   what is the actual distance in km?
   Proportion : _____
4. A car travels 60 km using 5 liters of fuel.
   How many liters of fuel are needed
   to travel 132 km?
   Proportion : _____

D Complete the tables and state whether the relationship is proportional.

1.

x	1	2	3	4	5
y	2	4	☐	8	☐

Is it proportional? ☐ Yes ☐ No

2.

Time (h)	1	2	3	4	5
Distance (km)	40	☐	120	160	☐

Is it proportional? ☐ Yes ☐ No

3.

Number of workers	2	4	6	8	10
Days	15	☐	5	☐	3

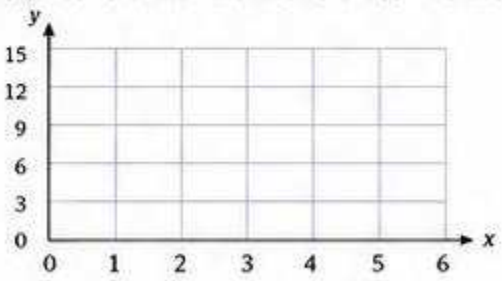
Is it proportional? ☐ Yes ☐ No

E Solve each problem using proportion.

1. 12 meters of cloth cost 360 LE.
   How much will 25 meters of the same cloth cost?
   Answer : _____
2. 6 books can be copied in 3 hours.
   How many books can be copied in 8 hours
   at the same rate?
   Answer : _____
3. 4 liters of juice are enough for 10 people.
   How many liters are needed for 28 people?
   Answer : _____
4. A recipe uses 3 eggs for 1 cake.
   How many eggs are needed for 15 cakes?
   Answer : _____

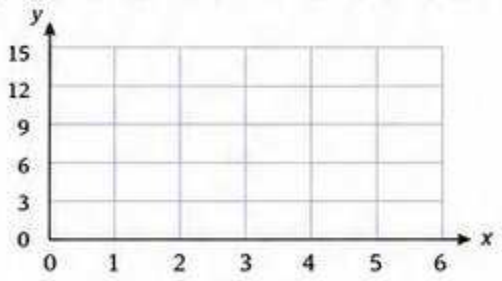
F Graph each set of values on the grid.
Then decide whether it represents a proportion.

1. (0, 0), (1, 3), (2, 6), (3, 9), (4, 12)



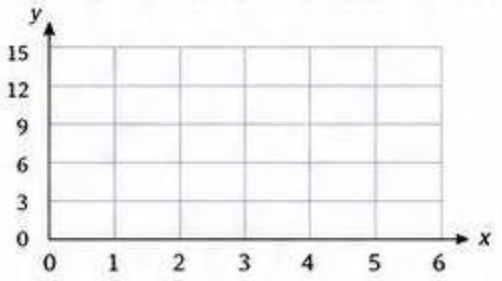
Proportion? ☐ Yes ☐ No

2. (0, 0), (1, 2), (2, 5), (3, 7), (4, 10)



Proportion? ☐ Yes ☐ No

3. (0, 0), (1, 4), (2, 8), (3, 12), (4, 16)



Proportion? ☐ Yes ☐ No

G Challenge Question

The ratio of the number of apples to the number of oranges in a basket is 4 : 5. If there are 36 apples in the basket and some oranges are removed so that the ratio becomes 4 : 3, how many oranges were removed?

Answer : _____

Teacher : _____ _____

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First: Scale Drawings

Introduction

When we draw large objects on paper, we cannot draw them in their real size, so we use a scale to represent the real object with a smaller or larger size.

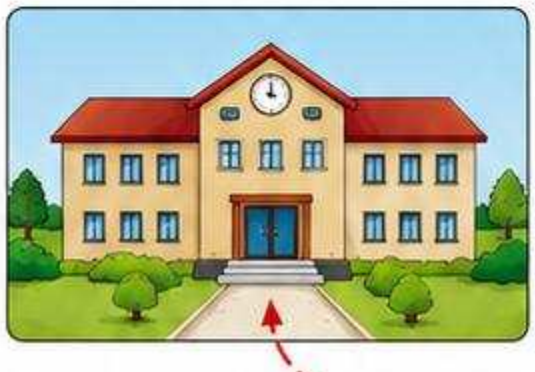
What Will You Learn?

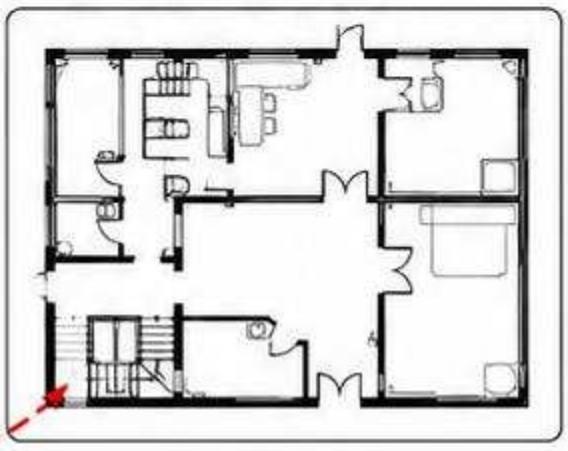
By the end of this lesson, you will be able to:

- Understand the meaning of scale drawing.
- Write a scale as a ratio.
- Decide whether the scale drawing is a magnification or a reduction.
- Find real lengths from a scale drawing.
- Find drawing lengths from real lengths.
- Use scales on maps to find distances.
- Solve problems in real life involving scale drawings.

Real-Life Idea

An architect draws a plan of a school on paper. Since the school is very large, he uses a scale so that the drawing becomes small and easy to read.





Basic Concept

A scale drawing is a drawing of an object where each length in the drawing represents a proportional length in reality.

Remember

1 m = 100 cm
1 km = 1,000 m
1 km = 100,000 cm
1 mm = 0.1 cm

Example 1 Understanding the Idea

Ahmed drew his house on paper. If the length of the house in the drawing is 6 cm and the real length is 18 m, write the scale of the drawing and explain it.

Solution

First, write both lengths in the same unit.

Real length = 18 m = 1,800 cm

$$\text{Scale of drawing} = \frac{\text{length in the drawing}}{\text{real length}} = \frac{6 \text{ cm}}{1{,}800 \text{ cm}} = \frac{1}{300}$$

So, the scale is 1 : 300.
This means that every 1 cm in the drawing represents 300 cm (or 3 m) in real life.

Note: The scale can be written as a ratio (1 : 300) or as a fraction $\left(\frac{1}{300}\right)$. Both mean the same thing.

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Applications of Ratio and Proportion

First: Scale Drawings

The Scale of a Drawing

$$\text{Scale of drawing} = \frac{\text{length in the drawing}}{\text{real length}}$$

Interpretation

The scale tells us how many units in the drawing represent one unit in real life.

Scale 1 : 500 means that every 1 unit in the drawing represents 500 of the same units in reality.

Remember

Convert all lengths to the same unit before working.

1 m = 100 cm
1 km = 1,000 m
1 km = 100,000 cm
1 cm = 10 mm
1 mm = 0.1 cm

Types of Scale Drawings

Magnification (Enlargement)

The drawing is larger than the real object.

Scale > 1

Example:

Scale 2 : 1 means the drawing is twice the real size.

Reduction (Minimization)

The drawing is smaller than the real object.

Scale < 1

Example:

Scale 1 : 200 means the drawing is smaller.
Every 1 unit in the drawing represents
200 units in reality.

Converting Units

From	To	Multiply by
m	cm	100
km	m	1,000
km	cm	100,000
cm	mm	10
mm	cm	0.1

★ Always use the same unit in the numerator and denominator.

Examples

Example 2

A map has a scale of 1 : 75,000.
How many kilometers in reality are represented by 3.5 cm on the map?

Solution

Scale 1 : 75,000 means 1 cm represents 75,000 cm.

3.5 cm represents 3.5 × 75,000 = 262,500 cm.

Convert to km: 262,500 ÷ 100,000 = 2.625 km.

Answer: 2.625 km.

Example 3

The length of a chair in the drawing is 8 cm.
The scale is 2 : 1.
What is the real length of the chair?

8 cm

Solution

Scale 2 : 1 means 2 cm in the drawing represents 1 cm in reality.

8 cm in the drawing represents

8 ÷ 2 = 4 cm in reality.

Answer: 4 cm.

Try It Yourself

1 Write the scale of each drawing as a ratio in simplest form.

a) 5 cm in the drawing represents 250 cm in reality.

b) 8 mm in the drawing represents 4 cm in reality.

2 The scale of a map is 1 : 50,000. How many meters in reality are represented by:

a) 2 cm on the map?

b) 7.5 cm on the map?

3 A model car has a length of 12 cm. The real car is 4.8 m long. What is the scale of the model?

.....

.....

.....

4 Decide whether each scale represents magnification or reduction.

a) 3 : 1

b) 1 : 500

c) 5 : 2

d) 1 : 20

Tip If the scale is greater than 1, the drawing is an enlargement.
If the scale is less than 1, the drawing is a reduction.

Teacher

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First: Scale Drawings

Finding Real Length from a Scale Drawing

To find the real length, use the formula:

$$\text{Real length} = \frac{\text{Drawing length}}{\text{Scale (as a fraction)}}$$

Or use: real length = drawing length × scale factor

(when the scale is written as 1 : n → scale factor = n)

Remember

Scale 1 : n

1 unit in drawing ↓ represents n units in real life.

So,

Real length = Drawing length × n

Examples

Example 1

A map has a scale of 1 : 60,000. The distance between two towns on the map is 7.5 cm. Find the real distance between them.

Solution

Scale 1 : 60,000 means 1 cm represents 60,000 cm in reality.

Real distance = 7.5 × 60,000 cm
= 450,000 cm
= 4,500 m = 4.5 km

Answer: 4.5 km

Example 2

A model of a bridge has a scale of 1 : 200. If the length of the bridge in the model is 12 cm, find the real length of the bridge.

Solution

Scale 1 : 200 means 1 cm represents 200 cm in reality.

Real length = 12 × 200 cm
= 2,400 cm = 24 m

Answer: 24 m

Example 3

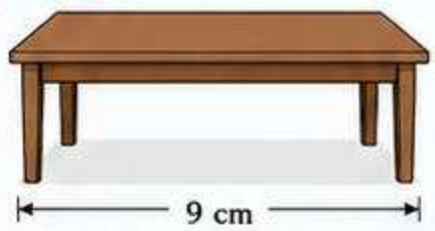
A designer draws a table on paper with a scale of 1 : 50. The length of the table in the drawing is 9 cm. Find its real length.

Solution

Scale 1 : 50 means 1 cm represents 50 cm in reality.

Real length = 9 × 50 cm
= 450 cm = 4.5 m

Answer: 4.5 m



Note

Always express the final answer in suitable and clear units (cm, m, km, mm, …).

Try It Yourself

1. A map has a scale of 1 : 100,000. The distance between two places on the map is 3.2 cm. Find the real distance between them.

   Answer: _____

2. A model airplane has a scale of 1 : 150. If the wingspan in the model is 18 cm, find the real wingspan of the airplane.

   Answer: _____

3. A photograph is an enlargement with a scale of 5 : 1. If the length of an object in the photo is 15 cm, what is its real length?

   Answer: _____

4. A scale drawing of a road is 6 cm long on a map with a scale of 1 : 25,000. Find the real length of the road.

   Answer: _____

5. A model tree is drawn with a scale of 1 : 75. The height of the tree in the model is 8 cm. Find the real height of the tree.

   Answer: _____

Think

If a scale drawing of a building has a scale of 1 : 300 and the real height of the building is 45 m, what will be its height in the drawing?

Answer: _____

Common Mistakes

- Using different units for the drawing and real length.
- Forgetting to convert units before solving.
- Multiplying when the scale is greater than 1 (should be dividing).

Tip

Write the scale as a fraction first, then use the formula. It helps you avoid mistakes.

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Finding the Drawing Length from the Real Length

To find the length in the drawing, use the formula:

Drawing length = Real length × Scale (as a fraction)

Or use: drawing length = real length ÷ scale factor

(when the scale is written as 1 : n → scale factor = n)

Remember

Scale 1 : n

1 unit in the drawing ↓ represents n units in real life.

So,

Drawing length = Real length ÷ n

Examples

Example 1

A garden is 30 m long in real life.
It is drawn on paper with a scale of 1 : 300.
Find the length of the garden in the drawing.

Solution

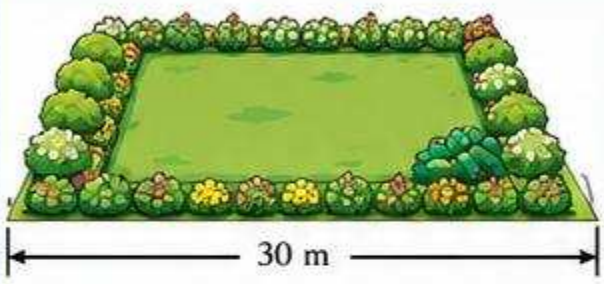
Scale 1 : 300 means 1 cm in the drawing represents 300 cm in reality.

30 m = 3,000 cm

Drawing length = 3,000 ÷ 300

= 10 cm

Answer: 10 cm



Example 2

The real width of a river is 180 m.
It is drawn on a map with a scale of 1 : 2,000.
Find the width of the river on the map.

Solution

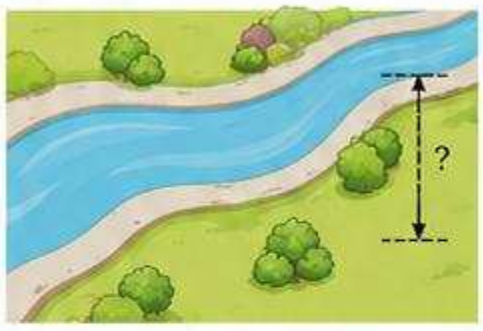
Scale 1 : 2,000 means 1 cm in the map represents 2,000 cm in reality.

180 m = 18,000 cm

Drawing length = 18,000 ÷ 2,000

= 9 cm

Answer: 9 cm



Example 3

A real door is 2.4 m wide.
It is shown in a plan with a scale of 1 : 40.
What is the width of the door in the plan?

Solution

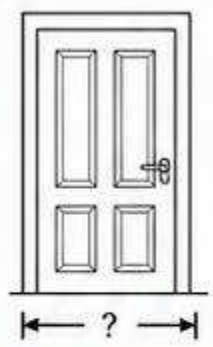
Scale 1 : 40 means 1 cm in the plan represents 40 cm in reality.

2.4 m = 240 cm

Drawing length = 240 ÷ 40

= 6 cm

Answer: 6 cm



Try It Yourself

1. A classroom is 8 m long in real life. It is drawn on paper with a scale of 1 : 200. Find its length in the drawing.

   Answer: _____ cm

2. A real table is 1.2 m long. It is drawn with a scale of 1 : 30. What is its length in the drawing?

   Answer: _____ cm

3. A bridge is 60 m long. It is drawn on a map with a scale of 1 : 3,000. Find its length in the map.

   Answer: _____ cm

4. A model car is drawn with a scale of 1 : 24. If the real length of the car is 4.8 m, find its length in the model.

   Answer: _____ cm

5. A football field is 90 m wide in real life. It is drawn with a scale of 1 : 500. Find its width in the drawing.

   Answer: _____ cm

Note

- When the scale is less than 1 (1 : n), the drawing is smaller than the real object.
- When the scale is greater than 1 (n : 1), the drawing is larger than the real object.

Tip

- Always convert the real length to the same unit used in the scale.
- Write the scale as a fraction ($\frac{1}{n}$) before using the formula.
- Check your answer by estimating first.

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Lesson 2

Applications of Ratio and Proportion

First: Scale Drawings

Graphical Scales (Bar Scales)

On maps, the scale is often shown as a line divided into equal parts. It helps us measure distances directly on the map.

This scale means:

Every 1 cm on the map represents 25 km in reality.

How to Use a Graphical Scale

1. Place the ruler's zero at the starting point.
2. Read the distance by following the scale.
3. Add the parts if the distance is more than one division.

Remember

If the bar scale is divided into n equal parts, and the last number on the scale is L, then:

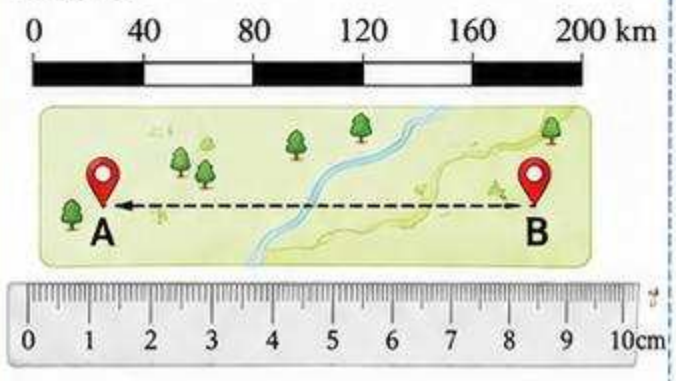
$$1 \text{ division} = \frac{L}{n} \text{ units}$$

1 cm on map $= \frac{L}{n}$ units in reality.

Examples

Example 1

Use the scale to find the real distance between A and B.



Solution

From the scale: 0 to 200 km is divided into 5 equal parts.

So, 1 division = 200 ÷ 5 = 40 km

1 cm on the map represents 40 km in reality.

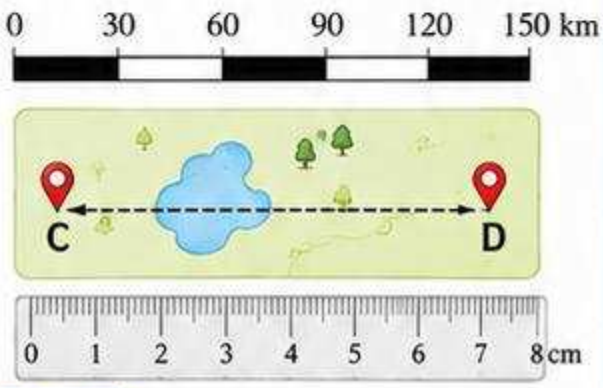
The distance on the map = 7.5 cm

Real distance = 7.5 × 40 = 300 km

Answer: 300 km

Example 2

Use the scale to find the real distance between C and D.



Solution

0 to 150 km is divided into 5 equal parts.

So, 1 division = 150 ÷ 5 = 30 km

1 cm on the map represents 30 km.

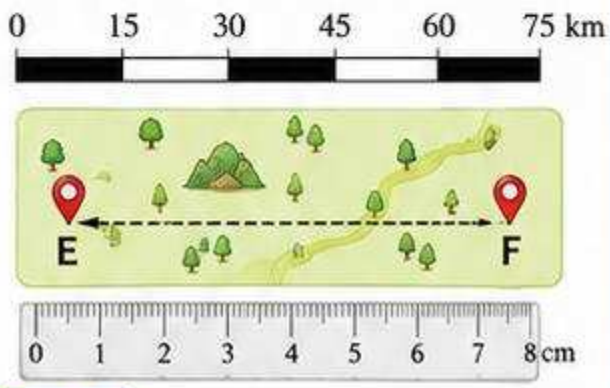
Distance on the map = 4.2 cm

Real distance = 4.2 × 30 = 126 km

Answer: 126 km

Example 3

Use the scale to find the real distance between E and F.



Solution

0 to 75 km is divided into 5 equal parts.

So, 1 division = 75 ÷ 5 = 15 km

1 cm on the map represents 15 km.

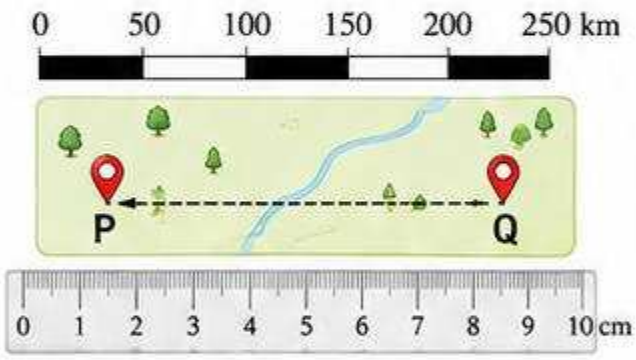
Distance on the map = 6.6 cm

Real distance = 6.6 × 15 = 99 km

Answer: 99 km

Try It Yourself

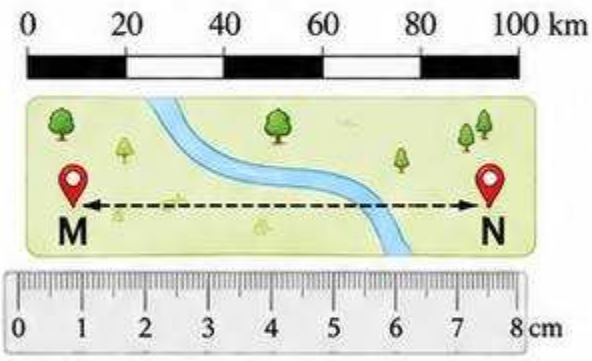
1. Use the scale to find the real distance between P and Q.



Distance on the map = _____ cm

Real distance = _____ km

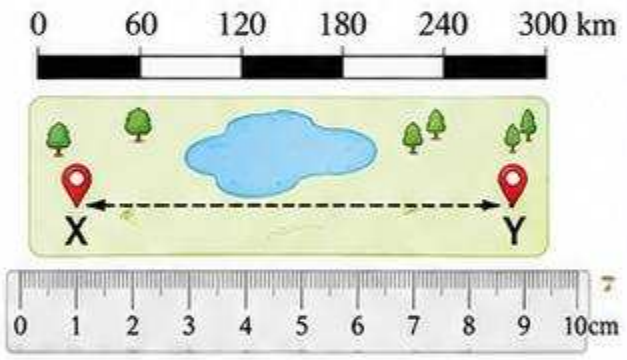
2. Use the scale to find the real distance between M and N.



Distance on the map = _____ cm

Real distance = _____ km

3. Use the scale to find the real distance between X and Y.



Distance on the map = _____ cm

Real distance = _____ km

Tip

- Always start from zero when reading a scale.
- Make sure the ruler is straight along the distance.
- If the line ends in the middle of a division, estimate carefully.

Note

Scale on maps makes it easy to read real distances without measuring the whole map.

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Unit 1 — Numbers and Operations on them

Lesson 2

Applications of Ratio and Proportion

First: Scale Drawings

Scale Drawings Involving Area

When a two-dimensional shape is drawn to a scale, the ratio of the areas is the square of the linear scale factor.

Rule:

If the scale of a drawing is $1 : n$ $(n > 0)$

then Area of drawing : Area in reality $= 1 : n^2$

or Area in reality = (Area of drawing) $\times n^2$

Remember

If the linear scale is $1 : n$

Length in reality = Length in drawing $\times$ n

Area in reality = Area in drawing $\times n^2$

Example:

If the scale is $1 : 5$

Area in reality = Area in drawing $\times 5^2$

= Area in drawing $\times 25$

Examples

Example 1

The figure shows a square park on a plan with a scale of $1 : 200$. If the side of the park in the plan is 6 cm, find the real area of the park.

Solution

Scale $1 : 200$ means 1 cm in the plan represents 200 cm in reality.

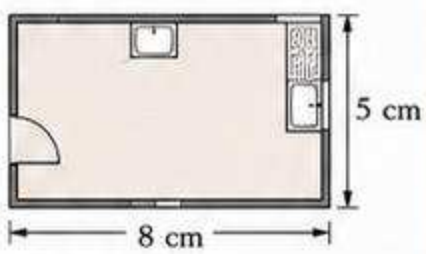
Real side length $= 6 \times 200 = 1{,}200$ cm $= 12$ m

Real area $= 12^2 = 144$ m^2

Answer: 144 m^2

Example 2

A room is drawn on a plan with a scale of $1 : 100$. The room in the plan is a rectangle 8 cm by 5 cm. Find the real area of the room.



Solution

Scale $1 : 100$

1 cm in the plan represents 100 cm in reality.

Real length $= 8 \times 100 = 800$ cm $= 8$ m

Real width $= 5 \times 100 = 500$ cm $= 5$ m

Real area $= 8 \times 5 = 40$ m^2

Answer: 40 m^2

Example 3

A model of a rectangular garden is drawn with a scale of $1 : 50$. The area of the garden in the model is 72 cm^2. Find the real area of the garden.

Solution

Scale $1 : 50 \Rightarrow n = 50$

Real area = Area in model $\times 50^2$

$= 72 \times 2{,}500$

$= 180{,}000$ cm^2

$= 18$ m^2

Answer: 18 m^2

Try It Yourself

1. A square field is drawn on a map with a scale of $1 : 300$. If the side of the field on the map is 4 cm, find the real area of the field.

Answer: _____

2. A rectangular hall is drawn with a scale of $1 : 150$. Its length on the plan is 9 cm and its width is 6 cm. Find the real area of the hall.

Answer: _____

3. A model of a rectangular swimming pool is drawn with a scale of $1 : 20$. The dimensions of the pool in the model are 15 cm by 10 cm. Find the real area of the pool.

Answer: _____

Note

If the linear scale is $1 : n$

- Length ratio $\rightarrow 1 : n$
- Area ratio $\rightarrow 1 : n^2$
- Volume ratio $\rightarrow 1 : n^3$ (for 3D shapes)

Common Mistakes

- Squaring the wrong number (always square the scale factor n, not the lengths).
- Forgetting to convert all lengths to the same unit before calculating area.
- Mixing up length scale with area scale.

Tip

Check your answer by estimating.
If the scale is less than 1 $(n > 1)$, the real area must be larger than the drawing area.
If the scale is greater than 1 $(n < 1)$, the real area must be smaller.

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Practice Exercises

1 Choose the correct answer:

1 If the scale of a map is 1 : 250,000, which of the following is true?

a) 1 cm represents 250 km b) 1 cm represents 25 km

c) 1 cm represents 2.5 km d) 1 cm represents 0.25 km

2 A drawing is at a scale of 2 : 1. This means the drawing is:

a) Half the real size b) Equal to the real size

c) Twice the real size d) Four times the real size

3 A scale of 1 : 5,000 is written as:

a) 5,000 : 1 b) $\frac{1}{5,000}$ c) 1 : 500 d) 1 : 5

4 The scale 1 : 750 means:

a) 1 cm in the drawing represents 750 cm in reality

b) 1 cm in the drawing represents 7.5 m in reality

c) 1 cm in the drawing represents 7.5 km in reality

d) 1 cm in the drawing represents 0.75 km in reality

2 Fill in the blanks:

1 The scale of a drawing = _____

2 Scale 1 : 1,000 means 1 cm in the drawing represents _____ cm in reality.

3 If the scale is 1 : n, then real length = drawing length × _____.

4 If the scale is 1 : n, then real area = drawing area × _____^{2}.

5 2 km = _____ m

6 75 mm = _____ cm

7 4.8 m = _____ cm

8 3 km = _____ cm

9 0.6 cm = _____ mm

10 1.2 m = _____ mm

3 Find the scale of each of the following:

1 3 cm in the drawing represents 15 m in reality.

Scale = _____

2 7 mm in a model represents 3.5 cm in reality.

Scale = _____

3 2.5 cm in a map represents 125 km in reality.

Scale = _____

4 18 cm in a plan represents 9 m in reality.

Scale = _____

4 Find the real length:

1 The length in the drawing is 6 cm and the scale is 1 : 500.

Real length = _____

2 The length in the drawing is 9 mm and the scale is 1 : 25.

Real length = _____

3 The length in the drawing is 12 cm and the scale is 1 : 2,000.

Real length = _____

4 The length in the drawing is 4.5 cm and the scale is 1 : 300.

Real length = _____

5 Find the drawing length:

1 The real length is 75 m and the scale is 1 : 250.

Drawing length = _____

2 The real length is 3.6 km and the scale is 1 : 60,000.

Drawing length = _____

3 The real length is 8 m and the scale is 1 : 40.

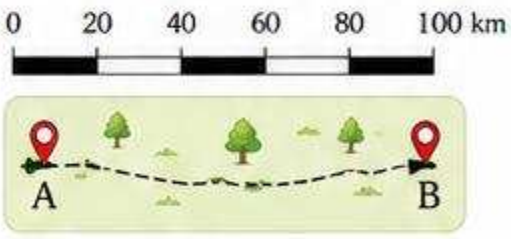
Drawing length = _____

4 The real length is 210 cm and the scale is 1 : 3.

Drawing length = _____

6 Use the given bar scale to find the real distance:

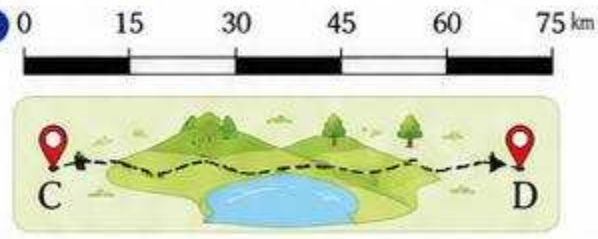
1



Distance on the map = _____ cm

Real distance = _____ km

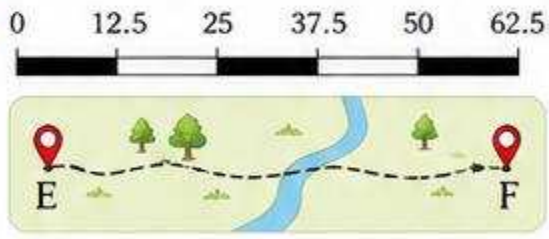
2



Distance on the map = _____ cm

Real distance = _____ km

3



Distance on the map = _____ cm

Real distance = _____ km

7 Solve the following problems:

1 A playground is 90 m long in real life. It is drawn on a plan with a scale of 1 : 250. Find its length in the plan.

2 A model car is 15 cm long. The real is 3.75 m long. Find the scale of the model.

3 A map has a scale of 1 : 80,000. If the distance between two towns on the map is 6.4 cm, find the real distance.

4 The real height of a tree is 18 m. In a model, its height is 6 cm. Find the scale of the model.

5 The real width of a river is 240 m. On a map, it is 6 cm wide. Find the scale of the map.

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